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Risk Perceptions, General Environmental Beliefs, and Willingness to Address Climate Change

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The research reported here examines the relationship between risk perceptions and willingness to address climate change. The data are a national sample of 1225 mail surveys that include measures of risk perceptions and knowledge tied to climate change, support for voluntary and government actions to address the problem, general environmental beliefs, and demographic variables. Risk perceptions matter in predicting behavioral intentions. Risk perceptions are not a surrogate for general environmental beliefs, but have their own power to account for behavioral intentions. There are four secondary conclusions. First, behavioral intentions regarding climate change are complex and intriguing. People are neither ''nonbelievers'' who will take no initiatives themselves and oppose all government efforts, nor are they ''believers'' who promise both to make personal efforts and to vote for every government proposal that promises to address climate change. Second, there are separate demographic sources for voluntary actions compared with voting intentions. Third, recognizing the causes of global warming is a powerful predictor of behavioral intentions independent from believing that climate change will happen and have bad consequences. Finally, the success of the risk perception variables to account for behavioral intentions should encourage greater attention to risk perceptions as independent variables. Risk perceptions and knowledge, however, share the stage with general environmental beliefs and demographic characteristics. Although related, risk perceptions, knowledge, and general environmental beliefs are somewhat independent predictors of behavioral intentions.

KEY WORDS: Risk perceptions; climate change; knowledge; environmental beliefs.

1. INTRODUCTION

A substantial literature on environmental risk perception has emerged since the late 1960s. The primary research foci have been on the nature of environmental risk perceptions, measurement considerations, and correlates with attitudinal and personal characteristics. A prevailing assumption in this literature is that people who perceive a relatively high likelihood of an adverse event are more likely to take personal meliorative steps and support government initiatives to do likewise, even in the face of required sacrifice. This assumption, however, has seldom been tested, especially for the case of long-term, uncertain environmental risks such as global warming.

Somewhat related to risk perceptions are considerations of the role of information and knowledge in the formation of environmental beliefs and risk perceptions. Environmental knowledge may increase or, in some cases, decrease perceptions of risk and thus indirectly relate to environmental behaviors. Or, increases in knowledge may directly affect environ-

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mental behaviors by heightening a sense of awareness and obligation and by providing cues for appropriate meliorative behavior. Knowing the causes of a problem and the ameliorative options should promote proenvironmental acts independent of risk perceptions and environmental values. This should be especially the case for "weak signal," uncertain environmental threats such as global warming. In such cases, information and awareness are essential for problem definition, appropriate attributions of blame, and knowing the appropriate behaviors. After all, history records extreme weather events blamed on the wrath of God, rockets fired into space, El Niño, or greenhouse gases—and proposed solutions can involve fasting, loving one another, rejecting modern technologies, or cutting the rates of emissions of carbon dioxide.

Concurrent with, but generally independent of, the evolution of risk perception studies has been research on environmental beliefs, attitudes, and values. Although the literature on public opinion often uses the terms "values," "beliefs," "attitudes," and even "paradigms" somewhat interchangeably, we use the term "general environmental beliefs" to refer to non-issue-specific cognitive orientations. A reasonable assumption characterizing this research tradition is that environmental cognitions are the bedrock of support for environmentally friendly or hostile behaviors and are the basis of environmental risk perceptions (Dunlap and Scarce, 1991). From this perspective, risk perceptions are an integral by-product of environmental beliefs and not independent causes of behavior.

We argue that the very nature of long-term, uncertain, environmental problems makes it likely that both specific risk perceptions and general cognitive orientations will significantly relate to proenvironmental behaviors. The general orientation reflects awareness and concern whereas the risk perceptions focus that concern on specific negative outcomes. They may be somewhat independent of each other, but both should strongly relate to behavioral intentions. We hypothesize, therefore, that a willingness to support personal and governmental meliorative behaviors is a partial function of:

- general environmental beliefs; and,
- risk perceptions as reflected in (1) expectations that the problem will or is happening, (2) expectations that negative consequences are likely for self and others, and (3) knowledge of the causes of the problem

Because we do not test actual behavior, all allusions to environmental behaviors in the remainder of this paper should be understood as indicating "behavioral intentions": specifically, intentions to engage in environmentally friendly behavior and support governmental environmental initiatives. Ajzen and Fishbein (1980) offer substantial research evidence that behavioral intentions and actual behaviors are highly correlated.

Scholars have proffered other variables as important for understanding both risk perception and the willingness to act in an environmentally benign manner. These include the demographic characteristics age (MacManus, 1996), gender (Schahn and Holzer, 1990, Davidson and Freudenberg, 1996; Bord and O'Connor, 1997), and education (Berger, 1997). The collective impact of these types of variables in multivariate models, however, has been quite limited. Environmentalism may have become such a consensual issue that social characteristics are no longer of great importance. We assess their relative impact on behavioral intentions.

Because one of our behavioral intention measures involves a degree of support for several government actions to address climate change, we include a measure of general support for government as a control variable.

This paper examines a simple model that links specific risk perceptions and knowledge to expressed behavioral intentions and hypothetical votes regarding the issue of climate change. We hypothesize that risk perceptions of climate change and knowledge of its causes will predict individuals' preferences regarding what (if anything) should be done to address climate change. We also hypothesize that general environmental beliefs, attitudes toward government competence, and demographics will relate to willingness to address climate change. The paper juxtaposes risk perceptions and general environmental beliefs as determinants of willingness to make voluntary efforts to reduce greenhouse gas emissions and support government efforts to do likewise.

2. BACKGROUND

In this study, "risk perception" is conceptualized as the perceived likelihood of negative consequences to oneself and society from one specific environmental phenomenon: global warming. Many studies report that general environmental beliefs predict behavioral intentions, but few include specific risk

perceptions as independent variables. The presumption is that risk perceptions and actions correlate, but little focused research has been done. Much of the limited research on this linkage has been applied to radon in homes, a risk that has few characteristics similar to climate change. Johnson and Luken (1987) analyzed radon testing and mitigation in Maine. They found no relation among radon levels, risk perceptions, and mitigation. More than half of those who had tested reported some form of mitigation, even though far fewer than half of the sample had radon test results above the 4pCi/l action guideline.

Fisher *et al.* (1991) summarize less discouraging results. A local supermarket chain collaborated with a local television station in the Washington DC area to make radon test kits available at reduced prices. Of homeowners with results above the action guideline, 13% reported taking mitigating action, compared with none of the homeowners who had results below the guidelines. For home sales in Boulder, Colorado, 43% of those above the guidelines reported mitigating (along with 7% of those below the guidelines). Thus, perceptions of higher risk are linked to risk-reducing behavior for radon in homes.

There also have been a few studies examining whether perceived risks in drinking water lead to risk-reducing behavior. Abdalla, Roach, and Epp (1992) found a significant correlation between household averting decisions to avoid using their contaminated community drinking water supply and perceptions of cancer risk from the water—but not between the extent of spending and the level of risk perceptions.

In 1986, Gillroy and Shapiro noted the general inattention to environmental risk perceptions in opinion surveys. One exception is the Baldassare and Katz (1992) survey in Orange County, California. They found that residents who assess air and water pollution to be a serious threat are more likely to report that they drive less, recycle, conserve water, and purchase environmentally safe products. A second exception is the work of McDaniels *et al.* (1997), who used ecological impact assessments to predict the perceived need to regulate each of 33 threats to watersheds.

The contingent valuation literature examines willingness to pay for public goods, including risk reduction. Rarely, however, do contingent valuation studies actually ask respondents how risky they assess environmental hazards to be. Knowing how much people are willing to pay to reduce a particular risk does not tell us whether they view that risk as highly probable and having severely negative consequences.

In contrast to the lack of attention to the link between risk perceptions and behavioral intentions, many scholars have examined the link between environmental beliefs and behavioral intentions. Conceptualizing general environmental beliefs well, however, is not a simple task. Stern, Deitz, and Kalof (1993) argue that environmental beliefs cluster into several different perspectives. They report that three varieties of environmentalism—altruistic, egoistic, and biospheric—correlate with willingness to take political actions to protect the environment. Altruistic environmentalism reflects concerns that environmental problems may harm other people. Egoistic environmentalism focuses on personal impact and is based on economic and sociobiological assumptions regarding human behavior (Hardin, 1968; Olson, 1965). In biospheric environmentalism, the focus is on nature and ecology. Conceptually, the Stern and Deitz biospheric environmentalism is similar to Dunlap's New Environmental Paradigm (1978), which focuses on whether the planet is a fragile place where humans must learn to accept limits on spaceship Earth. The New Environmental Paradigm has had widespread use and broad validation (Pierce *et al.,* 1987).

Although the strength of correlations between general environmental beliefs and behavioral intentions varies with particular intended behaviors and measures of general environmental beliefs, correlations are consistently positive both in studies that use data from the first decade of the modern environmental movement (Weigel and Newman, 1976; Weigel and Weigel, 1978; Dunlap and Van Liere, 1978; Hines, Hungerford, and Tomera, 1987) and more recent surveys (Gigliotti, 1992; Scott and Willets, 1994; Stern, Dietz, and Guagnano, 1995; Grob, 1995; Steel, 1996; Tarrant and Cordell, 1997).

Research into attitudes toward climate change has focused on how people think about climate change (Read *et al.,* 1994; Bostrom *et al.,* 1994; Kempton, Boster, and Hartley, 1995), not on linking risk perceptions to behavioral intentions. One exception is Elke Weber's interviews with 48 farmers (1997). She found consistent relationships between the belief that global warming is a reality and several reported and observed behaviors to reduce personal vulnerabilities.

3. METHODS

3.1. Participants

In spring and summer, 1997, 1225 adults (18 and older) mailed back completed questionnaires, a re-

sponse rate of 59%. We employed a modified Dillman (1978) method of a postcard, two mailings of the full survey with a $1 incentive in the first mailing, and, finally, phone calls to nonrespondents. The purchased names and addresses represent a random sample of residential addresses from the 48 contiguous states. In comparison with census population figures, our sample overrepresents males (62%) and persons 66 and older (24%). Weighting procedures produce only minimal changes in the tables for this paper, so we have not weighted the results.

Asked to participate in a study of public priorities for goals and issues affecting their communities, respondents answered $4\frac{1}{2}$; pages of questions about goals and comparative threat perceptions; $4\frac{1}{2}$; pages about climate change; $3\frac{1}{2}$; pages about their social and political values; and 2 pages of demographics.

3.2. Measures

3.2.1. Dependent Variables

Tables I and II provide the exact wording of the questions. Before moving to the independent variables, however, we must explain the context in which people answered. There is always a dilemma in survey research in determining what information to provide.

Table I. Voluntary Actions

	Not likely				Very likely
	1	2	3	4	5
Choose a car that gets good gas mileage (this would reduce the purchase of trucks, vans, and Bronco-type vehicles)	10%	10%	16%	24%	39%
Install more insulation and weatherize homes and apartments	5%	5%	15%	30%	45%
Car pool and drive less by using trains and buses more often	30%	20%	20%	15%	16%
Replace older appliances with more energy efficient new models (refrigerators, furnaces, dishwashers, and others)	9%	9%	21%	30%	31%
Use less air conditioning in the summer and less heat in the winter	18%	14%	26%	21%	21%

Numbers vary from 1209 to 1213 because of missing data.

Providing a great deal of information on both causes and potential consequences helps people reach informed judgments, but may change their thinking about an issue. In the case of climate change, the presentation of information about consequences is particularly problematic and difficult because of uncertainties. We decided to provide no information about potential consequences, but brief information about causes. Specifically, after answering questions about perceived causes, likelihood, and consequences of global warming, respondents received the following information:

> Let's continue the focus on global warming. Burning fuel for energy releases carbon dioxide (CO_2), the main "greenhouse gas," which can cause higher average temperatures. Each person in the United States is responsible for the emission of about 20 tons of CO_2 per year, so our country emits a total of 5 billion tons annually. The United States has 5 percent of the world's population, but about 20 percent of the world's human emissions of CO_2.
>
> The amount of CO_2 released to the atmosphere could be reduced significantly if Americans took certain steps. Taking into consideration the *costs and inconvenience* for each of the following actions, how likely is it that *most Americans* would willingly do each of these?

Respondents then checked whether most Americans are likely willingly to drive less, avoid buying a gas guzzler, improve their home insulation, replace older appliances, or use less air conditioning in the summer and less heat in the winter (data not reported). The next page of the questionnaire repeats the list, but this time asking respondents whether they themselves are likely to take each voluntary action. At the top of this page is the following:

> Now, again taking into consideration the *costs and inconvenience* for each action, how likely is it that *YOU PERSONALLY* would do each of these?

Table I reports these data.

The questionnaire turns next to the hypothetical referenda questions. Two are government programs that have an international focus: funding an international organization that would enforce a climate change treaty and support efforts to preserve rain forests. Two are regulatory: tougher corporate average fuel efficiency (CAFE) standards for automobiles and new requirements that public buildings save energy by reducing air conditioning in the summer and heat in the winter. Three approaches to reducing greenhouse gas emissions are taxes: an energy use tax on businesses, a "gas guzzler" tax on cars and vans that get poor gas mileage, and higher gasoline

Table II. Voting Intentions

	Definitely no	Probably no	Probably yes	Definitely yes
Government support for a new international organization that would enforce international treaties to reduce CO^2 emissions and help poor nations reduce greenhouse gases. This would cost taxpayers $100 ($200) million per year.	22%	33%	34%	11%
A government program to preserve rain forests throughout the world (forests absorb CO^2). This would cost taxpayers $100 ($200) million per year.	12%	19%	38%	31%
A requirement that automobile fuel efficiency be increased from the current average of 28 mpg to 33 mpg. To maintain comfort and performance, new car prices would go up by an average of $1000 ($2000).	13%	25%	42%	20%
A law requiring all public buildings (offices, schools, stores, libraries, etc.) to keep thermostats set at 65 (62) degrees or below in the winter and 75 (80) degrees or above in the summer. This would reduce the use of fuels that produce CO^2.	16%	31%	33%	20%
A 60-cent ($1) a gallon tax on gasoline, over and above existing gas taxes, to reduce driving, thus reducing CO^2 emissions.	51%	31%	12%	6%
A 5 (10) percent ''gas guzzler'' tax on cars and vans that get less than 25 miles to the gallon (an added $1000 ($2000) to the price of a $20,000 car). This would encourage the use of fuel-efficient cars.	21%	23%	33%	23%
An energy use tax on businesses to encourage greater fuel efficiency. This tax would raise the average price of most things you buy, including food and clothing, by 3 (6) percent $380 ($775) per person per year).	26%	36%	30%	8%

Numbers vary from 1180 to 1193 depending on missing data.

taxes. At the top of the page with the referenda items is the following:

> As noted previously, carbon dioxide (CO_2) is the main greenhouse gas. The U.S. releases 5 billion tons annually, or about 20% of the world's total CO_2 from human activity.
>
> Here are some other steps we might take to decrease the amount of CO_2 released to the atmosphere. For each one, indicate how you would *vote* in a *national referendum* on these steps. NOTE THAT *EACH* OF THESE WOULD REDUCE U.S. EMISSIONS BY *2%,* 100 MILLION TONS (*4%,* 200 MILLION TONS) PER YEAR.

Half the questionnaires listed the impact as a 2% reduction, and the other half as a 4% reduction. The survey instrument also varied the cost, with the higher number in parentheses in Table II. These variations in cost and impact were randomized among respondents. As these manipulations have no impact on the relationships reported in this article, we do not include them in any of the equations.

We executed a factor analysis for the voluntary action items and voting intentions separately. For items to form a reliable scale, factor analysis must show that these items form a single factor with an eigenvalue of at least 1.0 and reliability analysis must produce a Cronbach's alpha of at least .6. Each set of items meets scaling criteria (Cronbach's alphas of .74 for voluntary actions and .78 for voting intentions), so we can combine each set into scales: the voluntary action scale ranges from 5 to 25, reflecting the range of 1 to 5 on five items; the voting intentions scale ranges from 7 to 28, reflecting the range of 1 to 4 on seven items.

3.2.2. Independent Variables

The demographic measures are straightforward. The code for sex is 1 (male) and 2 (female). Age has seven categories, from 1 (18 or under) to 7 (66 or older). Education has six categories, from 1 (grade school) to 6 (graduate school).

The three ''climate change perceptions'' have the labels ''climate change likely,'' ''bad conse-

quences,'' and ''knowledge.'' ''Climate change likely'' is responses to one item: ''How likely do you think it is that average annual temperatures will increase by 3 degrees Fahrenheit within the next 50 years?'' Answers range from 1 (very unlikely) to 5 (very likely).

''Bad consequences'' is a scale (Cronbach's alpha = .88) composed of responses to seven specific items listed after an introduction, ''Suppose annual average temperature DOES increase by 3 degrees Fahrenheit over the next 50 years. Then how likely do you think each of the following would be?'' The seven items are: Many people's standard of living will decrease; My standard of living will decrease; Starvation and food shortages will occur in much of the world; Starvation and food shortages will occur where I live; It will be necessary for richer countries to make large donations of financial aid-to poorer countries; Rates of serious disease will increase; and My chances of suffering from a serious disease will increase. By summing the seven items with individual scores ranging from 1 (very unlikely) to 5 (very likely), we produce an additive measure that ranges from 7 to 35.

Perhaps risk perceptions (i.e., the ''bad consequences'' scale) are nothing more than a component of general environmental beliefs. To determine if the items that form the ''bad consequences'' scale form a separate factor from the items that comprise the measures of general environmental beliefs, we executed a factor analysis that included all items from both risk perceptions and general environmental beliefs. The seven items that comprise the ''bad consequences'' scale do form a separate factor (eigenvalue = 3.5). People assess the consequences of climate change differently from their general environmental beliefs.

''Knowledge'' is measured by subtracting scores on a scale comprised of *inaccurate* causes of climate change from scores on a scale comprised of *accurate* causes of climate change. The introductory material is: ''Now, let's focus on just one of these issues, global warming. Regardless of whether you know much about global warming, please indicate whether you think each of the following is a *major or primary cause* of global warming, a *minor or secondary cause,* or *not a cause* at all.'' For each item, responses range from 1 (not a cause at all) to 3 (major or primary cause). The accurate causes are pollution/emissions from business and industry, people driving their cars, use of coal and oil by utilities or electric companies, people heating and cooling their homes, and destruction of tropical forests. Inaccurate causes are use of aerosol spray cans, use of chemicals to destroy insect pests, depletion of ozone in the upper atmosphere, and nuclear power generation.

The scale for government working well derives from three items for which respondents selected one of two statements:

- Government is almost always wasteful and inefficient.
- OR
  Government often does a better job than people give it credit for. (selected) Check here if you **strongly** agree with the statement you selected.
- Government regulation of business is necessary to protect the public interest. (selected)
  OR
  Government regulation of business usually does more harm than good. Check here if you **strongly** agree with the statement you selected.
- Most elected officials care what people like me think. (selected)
  OR
  Most elected officials don't care what people like me think.
  Check here if you **strongly** agree with the statement you selected.

Each of the pairs produces a 4-point scale (strongly agree with the first choice, agree with the first choice, agree with the second choice, strongly agree with the second choice). The scale (Cronbach's alpha = .63) ranges from 3 to 12.

As discussed in Section 2, we identified measures of environmental beliefs from previous research. We executed a factor analysis for the items that had been components of the New Environmental Paradigm and scales of altruistic, biospheric, and egoistic environmentalism. What emerged from the factor analysis was two scales. The first we label ''fragile world'' because it seems to capture concerns that nature lacks resiliency. The five items that compose the scale (Cronbach's alpha = .74) are: The balance of nature is very delicate and easily upset by human activities; The earth is like a spaceship with only limited room and resources; The effects of pollution on public health are worse than we realize; Pollution generated here harms people all over the earth; and, Over the next several decades, thousands of species will become extinct. Scores range from 5 to 25. The second scale (Cronbach's alpha = .62) has two items that had been included in the Stern et al. (1993) measure

of egocentric environmental beliefs: Protecting the environment will threaten jobs for people like me (disagree); and, Laws to protect the environment limit my choices and personal freedoms (disagree). Scores range from 2 to 10.

4. RESULTS

There is great variability in intent to take voluntary actions. Table I shows that majorities say they are likely to avoid buying a gas-guzzler, install more insulation, and replace older appliances. A plurality would cut back on air conditioning and heat. The only item rejected by a plurality is ''car pool and drive less by using trains and buses more often.'' Whether for reasons of civil responsibility, environmental beliefs, or something else, many respondents indicate intentions to take voluntary actions.

There is also great variability in voting intentions, but also uncertainty and ambivalence. Table II shows that, for every vote except the gasoline tax, the modal category is either ''probably no'' or ''probably yes.'' Climate change is not a polarizing issue, but one about which most people are unclear on what government policies they should support. Respondents soundly reject only one policy, a big increase in gasoline taxes. The other referenda that would fail are an energy use tax on business and, by a narrow margin, support for an international organization to enforce treaties and help poor nations. A program to preserve rain forests and a requirement to raise automobile fuel efficiency standards would win by landslides. A gas guzzler tax and heat/air conditioning controls for public buildings would win narrower victories.

Table III presents simple bivariate correlation coefficients among the independent variables. Although 18 of the 28 coefficients are statistically significant, most relationships are weak. Only two relationships (between ''fragile world'' and ''climate change likely,'' and ''fragile world'' and ''bad consequence from climate change'') account for at least 10% of the variance. There is no problem of multicollinearity in using these variables in multivariate analyses.

Perceptions specific to climate change and general environmental beliefs are equally strong predictors of behavioral intentions for voluntary actions. Equation 1 of Table IV reveals that the demographic variables only account for 3% of the variance. When the three variables that measure specific perceptions about climate change enter the equation, explained variance (Eq. 2) jumps to 14%. Similarly, the demographic variables and general environmental beliefs explain 13% of the variance (Eq. 3). Combining general environmental beliefs with climate change perceptions (Eq. 4) only adds an additional 3% of explained variance to the 14% of Eq. 2.

All of the individual climate change perception and knowledge variables, and general environmental beliefs variables are statistically significant in the fully developed model (Eq. 4), although the knowledge variable loses much of its explanatory power when the environmental variables are added. A key finding is that the specific risk perception variables retain their predictive power even after the environmental belief measures enter the equation. Risk perceptions toward a specific environmental threat are not simply a surrogate for general environmental beliefs.

The explanatory power of the gender variable holds up strongly in all equations for voluntary actions. Women are more likely to indicate their intent to take voluntary actions regardless of the other variables in the equations. The results of Eq. 1 of Table IV are not surprising as previous research (Slovic, 1997; Davidson and Freudenberg, 1996; Bord and O'Connor, 1997) reports that women are more likely to perceive the world as risky, so presumably would be more willing to say that they would take steps to reduce greenhouse gas emissions. What is surprising is that the gender variable retains its explanatory power after the risk perception and environmental belief variables have entered the equation. The same point, expressed differently, is that male environmentalists are less likely than female environmentalists to intend to take voluntary actions for mitigate climate change.

The determinants of voting intentions are somewhat different than those of voluntary actions. Equation 1 of Table V shows that education, rather than gender, is the only statistically significant demographic variable, but demographics account only for 1% of the variance. Adding the ''government helpful'' variable (Eq. 2) increases explained variance to 7% Adding variables of perceptions about and knowledge of climate change (Eq. 3) raises explained variance to 26%. The environmental belief variables match the risk perception measures in explaining variance (Eq. 4); replacing the perception measures with general environmental beliefs results in 27% of the variance explained in voting intentions. The fully developed model (Eq. 5) has 33% of the variance explained, so general environmental beliefs add 7%

Table III. Correlation Matrix of Independent Variables

	Female	Age	Education	Climate change likely	Bad from climate change	Knowledge	Fragile world	Environmental policies do not harm me
Female	1							
Age	−.04	1						
Education	−.07*	−.11***	1					
Climate change likely	.22***	−.11***	−.08**	1				
Bad consequences from climate change	.07*	.02	.03	.28***	1			
Knowledge	−.14***	−.05	.23***	.02	.17***	1		
Fragile world	.11***	−.03	−.03	.43***	.36***	.20***	1	
Environmental policies do not harm me	.12***	−.01	.05	.19***	−.02	.07**	.23***	1

Cell entries are standardized regression coefficients.
* Significant at .05; ** significant at .01; *** significant at .001, all two-tailed tests.

to explained variance. As with the equations for voluntary actions, the risk perception and environmental beliefs measures share substantial variance, but, with voting intentions, each set adds considerable independent explanatory power.

Gender and age obtain statistical significance in the fully developed model. Once there are controls for views toward the government and climate change, and general environmental beliefs, men and older respondents are actually somewhat more likely to vote for government policies to address climate change than are women and the young. This finding for women is in stark contrast to their disproportionate support for voluntary actions. This finding may simply reflect the tendency for men to feel comfortable with the political world and women to prefer personal approaches to public problems (Gilligan, 1982; Verba, Schlozman, and Brady, 1997).

Table IV. Voluntary Actions Regressed on Demographics, Risk Perceptions, and Environmental Values

	1	2	3	4
Demographics				
Female	1.66***	1.27***	1.31***	1.11***
	(.28)	(.27)	(.27)	(.27)
Age	−.01	.07	−.01	.02
	(.09)	(.08)	(.09)	(.09)
Education	.19*	.18*	.18*	.16
	(.09)	(.09)	(.06)	(.09)
Climate Change Perceptions				
Climate change likely		.76***		.50***
		(.11)		(.11)
Bad consequences		.11***		.10***
		(.02)		(.02)
Knowledge		.22***		.14*
		(.07)		(.07)
General Environmental Beliefs				
Fragile world			.32***	.18***
			(.03)	(.04)
Environmental policies do not harm me			.18**	.19**
			(.06)	(.06)
Constant	14.19	9.13	7.19	6.09
Adjusted R^2	.03	.14	.13	.17
N	1169	1074	1126	1051

Cell entries are unstandardized regression coefficients, with standard errors in parentheses.
* Significant at .05; ** significant at .01; *** significant at .001, all two-tailed tests.

Table V. Voting Intentions Regressed on Demographics, Risk Perceptions, and Environmental Values

	1	2	3	4	5
Demographics					
Female	.29	.07	−.24	−.29	−.46*
	(.28)	(.28)	(.26)	(.25)	(.25)
Age	.02	−.05	.14	.07	.14*
	(.09)	(.09)	(.08)	(.08)	(.08)
Education	.35***	.27**	.22**	.26***	.21**
	(.09)	(.09)	(.08)	(.08)	(.08)
Government helpful		.50***	.38***	.37***	.33***
		(.06)	(.06)	(.06)	(.06)
Climate change perceptions					
Climate change likely			.89***		.50***
			(.10)		(.10)
Bad consequences			.16***		.13***
			(.02)		(.02)
Knowledge			.34***		.22***
			(.06)		(.06)
General environmental beliefs					
Fragile world				.46***	.27***
				(.03)	(.04)
Environmental policies do not harm me				.26***	.32***
				(.06)	(.06)
Constant	15.10	2.61	6.32	2.77	1.62
Adjusted R^2	.01	.07	.26	.27	.33
N	1133	1096	1017	1060	1002

Cell entries are unstandardized regression coefficients, with standard errors in parentheses.
* Significant at .05; ** significant at .01; *** significant at .001, all two-tailed tests.

5. CONCLUSIONS AND DISCUSSION

Our primary conclusion is that risk perceptions matter in predicting behavioral intentions. Risk perceptions are not a surrogate for general environmental beliefs, but have their own power to account for behavioral intentions. We think four secondary conclusions are worthy of mention.

First, behavioral intentions regarding climate change are complex and intriguing. People are neither ''nonbelievers'' who will take no initiatives themselves and oppose all government efforts to reduce greenhouse gas emissions, nor ''believers'' who promise both to make personal efforts and to vote for every government proposal. Instead, most people are in the middle, favoring some actions and opposing others. It is an error to assume that most opponents to a particular proposal also oppose doing anything.

Second, although risk perceptions and general environmental beliefs influence both voluntary actions and voting, there are significant differences among the demographic variables. Women are more likely to intend to take voluntary actions. For voting intentions, however, when the variables that measure climate change perceptions and environmental values are in the equation, it is better educated, older, men who are more willing to support government policies to impose public sacrifices in order to reduce greenhouse gas emissions. In summary, we find women disproportionately among supporters of voluntary actions, and the better educated disproportionately among supports of government policies.

Third, knowledge about the causes of the global warming is a powerful predictor of behavioral intentions, independent from believing that climate change will happen and have bad consequences. Even though information immediately prior to the voluntary action questions identifies causes of climate change for respondents, willingness to act is predicted by knowing the causes before reading this information. We thought that perhaps being knowledgeable is a surrogate for salience, that people who think climate change is an important issue become informed. When we introduce salience measures into the equation (not shown), knowing the causes retains its explanatory power. So, we return to our initial hypothesis that prior knowledge (not solely from reading information just before answering questions) about what causes climate change fosters behavioral intentions to act on those causes.

Finally, the success of the risk perception variables in accounting for behavioral intentions should encourage greater attention to risk perceptions as independent variables. The research on risk perceptions initially used psychometric scaling methods to illuminate perceptions of the riskiness of technologies and behaviors (Slovic, Fischhoff, & Lichtenstein, 1980; Slovic, 1987; 1992). More recent work has looked at risk perceptions of ecological systems (McDaniels, Axelrod, and Slovic, 1995; McDaniels *et al.,* 1997). This work has taught us much about the way people conceptualize risks, but rarely looked at the consequences of these perceptions for behavioral intentions or actual behavior. As generally assumed, our results show that risk perceptions and knowledge increase people's willingness to take steps that address environmental problems. Risk perceptions and knowledge, however, share the stage with general environmental beliefs and demographic characteristics. Although related, risk perceptions, knowledge, and general environmental beliefs are somewhat independent predictors of behavioral intentions. Our findings suggest some guidance for—as well as limits to what can be acomplished by—risk communication and information efforts.

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REFERENCES

Charles Abdalla, B. Roach, and Donald Epp. 1992. "Groundwater Contamination," *Land Economics,* **68**(2)**,** 163–169.

I. Ajzen and Martin Fishbein. 1980. *Understanding Attitudes and Predicting Social Behavior.* Englewood Cliffs, NJ: Prentice Hall.

Mark Baldassare and Cheryl Katz. 1992. "The Personal Threat of Environmental Problems as Predictor of Environmental Practices," *Environment and Behavior,* **29**(4)**,** 602–616.

Ida Berger. 1997. "The Demographics of Recycling and the Structure of Environmental Behavior," *Environment and Behavior,* **29**(4)**,** 515–531.

Richard Bord and Robert O'Connor. 1997. "The Gender Gap in Environmental Attitudes: The Case of Perceived Vulnerability to Risk," *Social Science Quarterly,* **78**(4)**,** 830–840.

Ann Bostrom, M. Granger Morgan, Baruch Fischhoff, and Daniel Read. 1994. "What Do People Know About Global Climate Change? I. Mental Models," *Risk Analysis* **14**(6)**,** 959–970.

Debra Davidson and William Freudenburg. 1996. "Gender and Environmental Risk Concerns: A Review and Analysis of Available Research," *Environment and Behavior,* **28,** 302–339.

Donald Dillman. 1978. *Mail and Telephone Surveys: The Total Design Methods.* New York: John Wiley and Sons.

Riley Dunlap. 1978. "The New Environmental Paradigm: A Proposed Measuring Instrument and Preliminary Results," *Journal of Environmental Education,* **9,** 10–19.

Riley Dunlap and Rik. Scarce. 1991. "The Polls—Poll Trends: Environmental Problems and Protection." *Public Opinion Quarterly,* **55**(4)**,** 651–672.

Riley Dunlap and Kent Van Liere. 1978. "Commitment to the Dominant Social Paradigm and Concern for Environmental Quality," *Social Science Quarterly,* **66,** 1013–1027.

Ann Fisher, Gary McClelland, William Schulze, and J. Doyle. 1991. "Communicating the Risk from Radon," *Journal of the Air and Waste Management Association,* **41**(11)**,** 1440–1445.

Larry Gigliotti. 1992. "Environmental Attitudes: 20 Years of Change?" *Journal of Environmental Education,* **24**(1)**,** 15–26.

Carol Gilligan. 1982. *In a Different Voice: Psychological Theory and Women's Development.* Cambridge: Harvard University Press.

John Martin Gillroy and Robert Shapiro. 1986. "The Polls: Environmental Protection," *Public Opinion Quarterly,* **50,** 270–279.

Alexander Grob. 1995. "A Structural Model of Environmental Attitudes and Behavior," *Journal of Environmental Psychology,* **15,** 209–220.

Garrett Hardin. 1968. "The Tragedy of the Commons," *Science,* **162,** 1243–1248.

Jody Hines, Harold Hungerford, and Audrey Tomera. 1986–87. "Analysis and Synthesis of Research on Environmental Behavior: A Meta-Analysis," *Journal of Environmental Education,* **18,** 1–8.

Reed Johnson and Ralph Luken. 1987. "Radon Risk Information and Voluntary Protection," *Risk Analysis,* **7**(1)**,** 97–107.

Willett Kempton, James Boster, and Jennifer Hartley. 1995. *Environmental Values in American Culture.* Cambridge: MIT Press.

Susan A. MacManus. 1996. *Young v. Old: Generational Combat in the 21st Century.* Boulder, CO: Westview Press.

Timothy McDaniels, Lawrence Axelrod, Nigel Cavanagh, and Paul Slovic. 1997. "Perceptions of Ecological Risk to Water Environments," *Risk Analysis* **17**(3)**,** 341–352.

Timothy McDaniels, Lawrence Axelrod, and Paul Slovic. 1995. "Characterizing Perception of Ecological Risk," *Risk Analysis* **15**(5)**,** 575–588.

Mancur Olson. 1965. *The Logic of Collective Action.* Cambridge: Harvard University Press, 1965.

John C. Pierce, P. Nicholas Lovrich, and Taketsugu Tsurutani. 1987. "Culture, Politics and Mass Publics: Traditional and Modern Supporters of the New Environmental Paradigm in Japan and the United States," *Journal of Politics,* **49**(1)**,** 54–79.

Daniel Read, Ann Bostrom, M. Granger Morgan, Baruch Fischhoff, and Tom Smuts. 1994. "What Do People Know About Global Climate Change? II. Survey Studies of Educated Laypeople," *Risk Analysis* **14**(6)**,** 971–982.

Joachim Schahn and Erwin. Holzer, "Studies of Individual Environmental Concern: The Role of Knowledge, Gender, and Background Variables," *Environment and Behavior* **22**(6), 767–786 (1990).

David Scott and Fern Willits. 1994. "Environmental Attitudes and Behavior: A Pennsylvania Survey," *Environment and Behavior,* **26**(2)**,** 239–260.

Paul Slovic. 1997. "Trust, Emotion, Sex, Politics, and Science: Surveying the Risk Assessment Battlefield," *University of Chicago Legal Forum,* **1977,** 59–99.

Paul Slovic. 1992. "Perception of Risk: Reflections on the Psycho-

metric Paradigm.'' In *Social Theories of Risk,* eds. Sheldon Krimsky and Dominic Golding. New York: Praeger. 117–152.
Paul Slovic. 1987. ''Perceptions of Risk,'' *Science,* **236,** 280–285.
Paul Slovic, Baruch Fischhoff, and Sarah Lichtenstein. 1980. ''Facts and Fears: Understanding Perceived Risk.'' In *Societal Risk Assessment: How Safe Is Safe Enough*? eds. Richard Schwing and Walter Alberts. New York: Plenum. 181–214.
Brent Steel. 1996. ''Thinking Globally and Acting Locally? Environmental Attitudes, Behavior, and Activism,'' *Journal of Environmental Management,* **47,** 27–36.
Paul Stern, Thomas Dietz, and Gregory Guagnano. 1995. ''The New Ecological Paradigm in Social–Psychological Context,'' *Environment and Behavior,* **27**(6)**,** 723–43.
Paul Stern, Thomas Dietz, and Linda Kalof. 1993. ''Value Orientations, Gender, and Environmental Concern,'' *Environment and Behavior,* **25**(3)**,** 322–348.
Michael Tarrant and H. Ken Cordell. 1997. ''The Effect of Respondent Characteristics on General Environmental Attitude-Behavior Correspondence,'' *Environment and Behavior,* **29**(5)**,** 618–637.
Sidney Verba, Kay Schlozman, and Henry Brady. 1997. *Voice and Equality: Civic Voluntarism in American Politics.* Cambridge: Harvard University Press.
Elke Weber. 1997. ''Perception and Expectation of Climate Change: Precondition for Economic and Technological Adaptation.'' In *Environment, Ethics, and Behavior.* eds. Max Bazerman, David Messick, Ann Tenbrunsel, and Kimberly Wade-Benzoni. San Francisco: Jossey-Bass. 314–341.
Russell Weigel and Lee Newman. 1976. ''Increasing Attitude Behavior Correspondence by Broadening the Scope of the Behavioral Measure,'' *Journal of Personality and Social Psychology,* **33,** 793–802.
Russell Weigel and Joan Weigel. 1978. ''Environmental Concern: The Development of a Measure,'' *Environment and Behavior,* **10,** 3–15.